

Compressed Air

DEVOTED TO THE USEFUL APPLICATION
OF COMPRESSED AIR.

Vol. I.

NEW YORK, SEPTEMBER, 1896.

No. 7



Compressed Air Power Plant at
Jerome Park, N. Y. . . .

Sterilized Air for Preservation of
Fruits, Etc.

Compressed Air and its Econo-
mies in the Foundry. . .



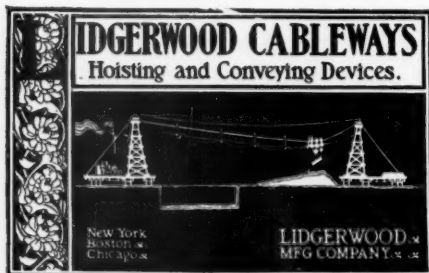
LIDGERWOOD M'F'G CO.,

96 Liberty Street,

Boston.

New York.

Chicago.



Send for our new 109 page Illustrated Pamphlet, which is devoted to a description of our different appliances and especially adapted for Canal and Trench Excavation, Dam Construction, Wall and Pier Building, Open Pit Mining, Quarrying, Logging, Handling of Earth and General Contract Work.

FISKE BROTHERS REFINING CO.

— HIGH GRADE —

LUBRICANTS



SPECIALLY MANUFACTURED FOR

**AIR COMPRESSORS, AIR DRILLS,
STEAM DRILLS, STEAM ENGINES.**

OFFICE AND SALESROOM:

**59 WATER STREET,
NEW YORK, U.S.A.**

THE PELTON WATER WHEEL

Embracing in it variations of construction and application

THE PELTON SYSTEM OF POWER.

In simplicity of construction, absence of wearing parts, high efficiency and facility of adaptation to varying conditions of service, the **PELTON** meets more fully all requirements than any other wheel on the market. Propositions given for the development of water powers based upon direct application, or **Electric Transmission** under any head and any requirement as to capacity.

Compressed Air Transmission.

No other wheel is so well adapted to this purpose. Where the head admits, it can be attached to compressor shaft direct, and serve for prime mover and fly wheel as well.

Correspondence Invited. Catalogues Furnished upon Application. Address,

PELTON WATER WHEEL CO.,

121-123 MAIN STREET, SAN FRANCISCO, CAL.

143 LIBERTY STREET, NEW YORK.

BOSTON.

NEW YORK.

PITTSBURG.

CHICAGO.

ST. LOUIS.

National Tube Works Company,

MANUFACTURERS OF

Standard Steam, Gas and Water Pipe.

Locomotive and Stationary Boiler Tubes.

Special Flanged Pipe for Compressed Air.

Pump Columns for Mines.

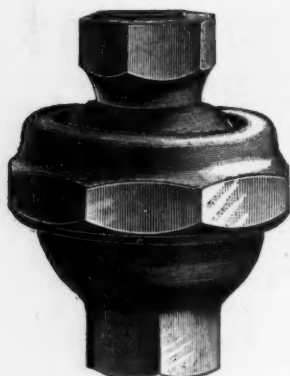
**Special Light Lap-Welded Pipe, fitted with the
Converse Patent Lock Joint for Water and Gas
Mains.**

**Cylinders with Dished or Flat Heads for Carbonic
Acid and other Gases.**

NEW YORK OFFICE: HAVEMEYER BUILDING.

COMPRESSED AIR.

An Important Connecting Link in Compressed Air Service



The Moran Flexible Joint

For high pressure, indispensable.

Tightness, safety, flexibility and durability assured.

Parties making experiments with Compressed Air may have the use of the "Moran Joint," free for a limited time.

MORAN FLEXIBLE STEAM JOINT CO.,

LOUISVILLE,

- - - - -

KENTUCKY.

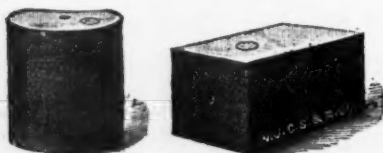
ESTABLISHED 1858.

"Our Name and Brand a Guarantee of Quality."

High Grade Rubber Goods.

CHANNELING SPRINGS.

BELTING.
TUBING.
VALVES.
HOSE
TUBING.



SPRINGS.
MATS.
MATTINGS.
GASKETS.
PLAY PIPES.

LINEN AND COTTON HOSE.

NEW JERSEY CAR SPRING & RUBBER COMPANY,

MAIN OFFICE AND WORKS:

Wayne and Brunswick Streets, Jersey City, N. J.

BRANCH OFFICE: 10 BARCLAY ST., NEW YORK.

COMPRESSED AIR.



A MONTHLY PUBLICATION DEVOTED TO THE USEFUL
APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - - Editor and Publisher
A. E. KENNEY, - - - Managing Editor
A. NEWTON, } - - - Associates
J. E. QUINTERO, }

Subscription, including postage, United States,
Canada and Mexico \$1.00 a year. All other coun-
tries, \$1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers,
contractors, inventors and others interested in
compressed air.

All communications should be addressed to
COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114a Queen Victoria Street.

Those who fail to receive papers promptly will
please notify us at once.

Entered as Second-Class Matter at the New York,
N. Y., Post Office.

VOL. I. SEPTEMBER, 1896. No. 7.

Nobody doubts the supremacy of compressed air as a brake for cars. When Mr. Westinghouse proposed the air brake at a meeting of the Association of Railway Master Mechanics, his plans met with almost unanimous criticism and disapproval. It was said that electricity was a more promising power for this purpose, and it was urged that railway engineers should look closely to the developments in electrical science as affording the most promising field for improvements in brake service. We have to-day more than twenty-five thousand air compressors in use for this purpose, and the air brake is a conspicuous object lesson to those who, on the advice of experts, are inclined to turn down the compressed air tram car.

Mr. J. H. McConnell, Supt. M. P. & M. Union Pacific system of Omaha, Neb., will attend a banquet given by the Western Railway Club at the Auditorium, Sept. 15.

He has been requested to respond to the toast, "Compressed air for shop appliances," which he agreed to do. Mr. McConnell is a practical inventor, fertile in knowledge concerning compressed air appliances.

During the heated term, while most people were sweltering on account of the high temperature and humidity, we received a communication from Mr. F. A. Kirby, Supt. of the Detroit Dry Dock Co., Wyandotte, Mich., which contained this paragraph for our contemplation:

"As I write, cool, fresh air is being circulated through my office, coming through a hose leading from our air reservoir. It not only cools the office and myself, but keeps the flies away as well. So much for personal comfort."

Mr. Kirby evidently believes in making practical use of compressed air.

The Contagion of Ideas.

In this most practical age, and in this magazine, whose province and purpose are of the most practical character, it might seem that we owe an apology to our readers for the above caption, which smacks of the theoretical and the occult. A little further thought, however, will convince the most hard-headed that there is, in fact, no divergence here from our chosen field; that in recording the progress of the development and application of the power of compressed air, we must, to be logical and consistent, take note also of the rapid advance of the scientific and mechanical and inventive minds upon this comparatively new domain.

Behind every achievement of man, the unseen mental forces have been in operation. Every product of man's skill and effort is only the visible demonstration of his silent and unseen thought. Thus it has been truly said, that the massive beauty of St. Peter's at Rome existed clearly in the mind of Michael Angelo before a stone

was laid. In short, scientifically speaking, thought is the creative force of the world. Ideas are living germs, which not only produce after their kind, but spread and disseminate, and find lodgment and germinate, in the minds of others.

It is this interesting phase of the situation—the contagiousness of ideas—that we desire to bring to the attention of our readers.

There are times when the very atmosphere seems charged with one class of ideas, such as in times of war, revolution, or great political crises. There are also times when *special* ideas affect *special* classes, as in the case of a great public demand for improved transportation, lighting, heating, or power.

The Patent Office teems with illustrations of the tremendous waves of inventiveness that at such times sweep over the land. Ideas, in fact, are so tangible that they are subject to the law of demand and supply, and their production is stimulated largely under the call of a general demand, as above indicated.

With one exception, that of electricity, there has appeared in modern times no such rapid and extensive spread of ideas on any one subject as on that of compressed air in the past few months; and our position as the pioneer in this special field enables us to observe this progress with great accuracy. We have seen this commonplace subject raised in a few months to the plane of a science. This common air, which we thought we fully understood, is now seen to possess qualities finer and mightier, and to be controlled by laws more complex and varied, than any of those mighty forces of nature which man has sought to harness to his use.

Not alone the technical and scientific, but the people generally, are turning to this great subject with enthusiasm and energy.

We venture to say that the possibilities of compressed air to the practical and ben-

eficial uses of mankind will surpass that of any other force; for as it is the universal element of the world, so does it contain resources of the most far-reaching character for man's use.

Our purpose, therefore, in this magazine is to keep pace with the evolution of this science in *all* its phases, however rapid and vast its progress may be.

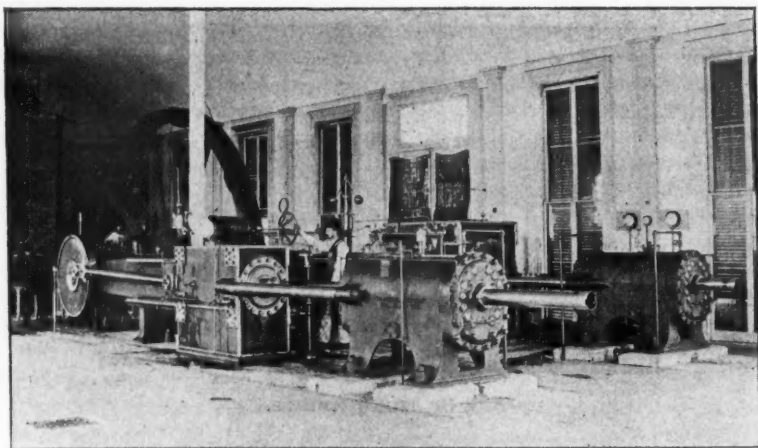
The Compressed Air Power Plant at Jerome Park, N. Y.

The Aqueduct Commissioners of the city of New York have now in active progress of construction two important works to increase the water supply of New York city. One is the new Croton dam, designed to increase the size of the present Croton Lake and thereby impound a greatly increased water supply for the city at large.

From the present Croton Lake two aqueducts, the old one of 1840, the other the new one completed in 1890, run to the city, delivering their water directly into the reservoirs in Central Park. The city of New York has had one policy as to its water supply; it has always worked on the lines of an increase of reservoir capacity by addition, the old reservoirs being preserved.

To provide for additional storage capacity for direct use in the city, construction operations are now in progress on what is known as Jerome Park reservoir, in Fordham, in the annexed district.

Here Jerome Park, with its famous old race course on which so many celebrated horses have been ridden to defeat or victory, with a quantity of adjacent territory, has been selected for a reservoir. The ground offers fair advantages in point of elevation and configuration; its vicinity to the city and its situation in the heart of the annexed district make it peculiarly available for the purpose. The area of about 5,800 feet long and 2,800 feet wide is to be surrounded by an embankment and



THE POWER PLANT—JEROME PARK, N. Y.

the bottom is to be excavated until good surface is reached, so as to establish an available depth of 33 feet 6 inches. This will involve a very large amount of excavation; the engineers having estimated that there will be nearly seven million of cubic yards of excavation to be made, of which 3,165,000 will be in solid rock.

The reservoir will be bounded on the west by Sedgwick avenue, on the east by Jerome avenue, north by Van Cortlandt Park, and south by Kingsbridge Road.

Mr. John B. McDonald secured the contract for building the reservoir in August, 1894. He examined the various methods for facilitating the work and doing it economically. Being a man of practical methods, he went into the examination with great thoroughness, and finally decided that he would adopt the compressed air central plant system as the most efficient and economical.

The plan is to locate a compressor at a central point, compress the air into a large storage receiver and from thence conduct it in pipes to wherever it is needed. Consequently a plant of this kind was procured. An 8-inch pipe is laid from the

storage tank and takes a straight course to the northeasterly corner of the work.

This pipe is tapped at various points, and each lateral supplies air to drills and other apparatus. These drills, hoists, pumps, etc., are located in various parts of the tract. They may all be in use at one time if occasion requires it, or only one machine need be in use. This distribution of air power on the "European plan" has effected some wonderful economies.

There are 14 rock drills, 14 hoisting engines, and 3 water pumps at work during the day. They are supplied by power from the central plant, which consists of one Ingersoll-Sergeant Duplex Corliss Condensing Air Compressor, steam cylinder 24 and 44 x 48; two air cylinders, 24 $\frac{1}{4}$ x 48, capable of producing 540 H. P. at a pressure of 80 pounds at the air receiver. Steam is made for this compressor by a Hogan Water Tube Boiler, manufactured by the Hogan Boiler Co. of Middletown, N. Y., the nominal rating of which is 240 horse power. The pipe leading from the receiver is 8 in. in diameter and carries the main supply of air to the individual machines. At a distance of 2,000 feet the air



ONE OF THE QUARRIES.

passes through a Sergeant Reheater. This reheater consists of two cast iron shells, which are bolted together. In appearance it resembles a truncated cone. It keeps the velocity of the air constant. The air being hot, it has greater volume, and would consequently increase the friction if there was no room for expansion. Tests have been made with this heater, and the results show that 340 cubic feet of free air per minute, at 40 lbs. pressure, can be reheated so that a gain of 35 per cent. is imparted to the energy of a pound of air.

The point where the economy is immediately effected is in the operation of the drills, hoists and pumps. Ordinarily these would be run by separate boilers requiring the attendance of an engineer and stoker, and the extra labor of hauling fuel and

water to each boiler. This performance is dispensed with by the air power being transmitted from the central station.

Aside from the reduction in expense, the convenience of having a power that can be used at any moment and without the annoyances attending the care of individual boilers for each machine facilitate the work vastly.

The whole work of excavation is reduced to as small a use of human effort as can well be devised at this time.

With the use of steam for the operation of drills, considerable water—condensed steam—collects in the pipe, even in the short time consumed in changing bits or moving from one hole to another. This must be worked out through the exhaust before the drill can begin to do good work. If this water from the different drills and pumps could be collected, it would be found to amount to a great many barrels in the course of a day. Each cubic foot of water wasted by condensation represents one horse power. There is another and serious loss with steam—that of loss of capacity of the drills. With full pressure of dry elastic compressed air at the drills, more work will be done than by the wet steam, a less number of drills, drill

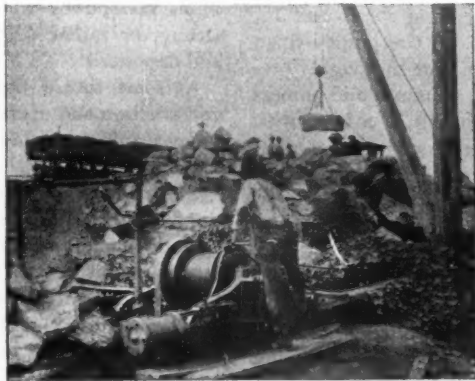


RE-HEATING THE AIR.

runners and helpers are required for the same work, and these various reductions in the pay roll and coal bill may amount to the cost of the plant before it is worn out. It is a common expression of quarrymen who have adopted compressed air after using steam, that "two drills will do more work with air than three with steam."

There are several other items, representing in the aggregate a large amount, that would be difficult to name, that is saved by the Jerome Park plant. For instance, a cheaper grade of hose can be used with air, and will outwear several lengths of steam hose. As a matter of fact, quarry-

nomical boiler plant, a compressing engine of high efficiency, fitted with an entirely automatic system of governing devices, using steam expansively, and requiring steam only in exact proportion to the amount of air being used. This disposes of all annoyance and expense incidental to supplying coal and water to a number of different boilers, and there is only one fireman, and one boiler plant to keep in repair. All annoyance and expense from frozen pipes in cold weather, smoke, exhaust steam and ashes in the quarry are avoided.



HOISTING A 3 TON ROCK BY AIR POWER.

men using compressed air find that the saving in hose alone equals the expense of keeping up the plant.

Less oil is required with air than steam. A little oil will last for hours in an air cylinder and will ease the working of the machine. Steam burns the oil out in a few minutes.

It is evident that greater economy will be realized by the use of one central plant placed where fuel and water are most accessible, removed from all danger from blasts, falling derricks, etc., not subject to constant removal, provided with an eco-

In a recent article Mr. Frank Richards suggests the use of compressed air as a cure for hay fever. If the sufferings of those afflicted with this dread disease may be alleviated by its use, a most important application has been discovered.

Janney & Steinmet of Philadelphia, Pa., are prepared to furnish cold or hot drawn steel bottles, seamless and welded for storing and transporting air or gasses under high pressure.

Sterilized Air for the Preservation of Fruits and Provisions.

What has become generally known as the "Perkins Process" for the conservation of perishable products, opens a new field for scientific research, as well as the use of compressed air.

The system attempts to—and so far the results prove it does—check the two prime factors of decay, viz., temperature and humidity. The latter has been almost entirely overlooked in present methods, and yet is of the greater importance.

It is no unusual occurrence in the pure, rarified atmosphere of the Sierras, at an altitude of 3,000 feet and over, even at a temperature ranging from 80° to 100° F., to have fruit—noticeably the grape—ripen and without decay become thoroughly preserved on the stem. Hunters and miners keep their meats hanging in a tree, with the free air of heaven blowing around it and for weeks cut their delicious, full flavored steaks, until the whole is used.

Following nature's course and guidance, after years of patient study, with chemical, microscopical and mechanical tests and experiments, the process has developed into a practical and effective service.

A brief article could not do justice to the treatment, from a scientific standpoint, of the subject of decay in animal or vegetable life. The Q. E. D. that a new life comes into existence on the death of every old one, is positive. The delicate peach hangs a perfect picture of beauty on its branch, the ruddy blush half hidden among the glistening leaves. It is just ready to finish the ripening—the first stages of its decay. The warmth of the atmosphere and the sun's rays set the acid and sugar into fermentation; the carbonic acid gas developed pushes outward through the flesh, mellowing and fitting it for a luscious morsel, but at the same time carrying a viscid moisture to the surface, and there on the beautiful skin are the resting spores of the mycelium, awaiting the moisture and warmth to vital-

ize. After vitalization, there is the union of the hyphae, or the male and female spores, followed by the perfecting of fungus growth in root, trunks, branch, bud, blossom, and explosion of the seed bulb, sending its innumerable spores in every direction, to hasten the work of destruction and decay on some other form of vegetable life. Clearly, then, perfect conservation must regulate temperature, absorb moisture, dispose of the carbonic acid gas and impurities, and sterilize the growth of the fungus.

Compressed air under proper pressure is thoroughly sterilized, and one of the principal features of the "process" is the ingenious method by which the moisture is wrung, or rather separated from the air and deposited.

At some future time we may note the construction and operation of this service for car and steamship transportation and for storage purposes.

At Dr. Perkins' laboratory in Chicago, the tests for compression, expansion, friction, drying and sterilizing are developing new possibilities for other purposes than those the inventor at first intended.

Although the "process" is in its infancy, machinery is being manufactured for the service in several foreign countries where the greater interest seems to be manifested in the introduction of improved methods for transportation.

The Hardie Compressed Air Motors are still running on the tracks of the Third Avenue Railway Company, in New York. Recently a test was made for the purpose of trying the motor on grades. Several prominent gentlemen who are interested in street car practice rode on the car and it responded to every requirement. One motor made four round trips—seventeen miles—carrying passengers, and at the end of the experiment 300 pounds of air pressure was left in the cylinders.

COMPRESSED AIR.

(CONTINUED.)

Experiments were made under the personal supervision of Prof. Denton at the Stevens Institute of Technology, to determine the relative effects in air compressors of water injection and water jackets. An extended controversy had been carried on

were not reliable because of leakage. It was only on such grounds that the proximity of the pressure line to the isothermal could be explained away. In the Stevens Institute tests the greatest care was exercised to secure air-tight pistons and valves, and as these experiments were unbiased and in the hands of experts, the results may be accepted as conclusive so far as in-

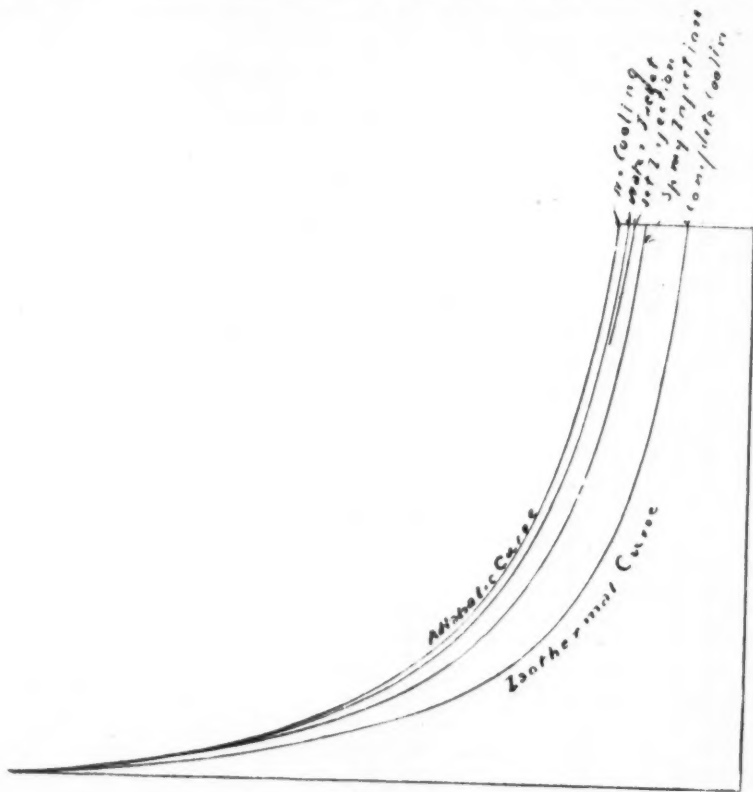


FIG. 6.

in the "Engineering and Mining Journal" between the writer and others upon the question whether or not the injection of water reduced the temperature and increased the efficiency. It was claimed by some that the efficient indicator cards taken from certain injection compressors

indicating isothermal economy by an efficient system of injection. Fig. 6 herewith represents graphically the results obtained at the Stevens Institute.* No clearance is shown, because the purpose of the illustration is to show the comparative effect of the

* From a paper by Mr. R. A. Parke.

TABLE IV.—SHOWING THE RELATIVE QUANTITY OF WORK REQUIRED TO COMPRESS A GIVEN VOLUME AND WEIGHT OF AIR, BOTH DRY AND MOIST—ALSO RELATIVE VOLUMES WITH AND WITHOUT INCREASE OF TEMPERATURE FROM COMPRESSION.

Tension in Atmospheres.		Compression at a Constant Temperature. Mariotte's Law.				Compression with Increase of Temperature.										Loss of Work in Compressing one Cubic Meter of Gas into Heat and Lost.		Percentage of Water to Air Required.		Dry.		With sufficient Moisture	
Volume		Work of Compression.		Volume		Work of Compression. (Dry.)		Temperatures. (Dry.)		Ratio of Greater to Lesser Temperature.		Per-centage of Work Compressed in Conversion of Heat into Lost.		Final Temperature if Water is used in Compression.									
Cubic Meters in Kilogram-meters.	Feet in Foot Pounds.	Cubic Meters in Kilogram-meters.	Feet in Foot Pounds.	Cubic Meters in Kilogram-meters.	Feet in Foot Pounds.	Cubic Meters in Kilogram-meters.	Feet in Foot Pounds.	Cent.	Fah.	Absolute.													
0.1	7190	1468	0.612	7932	1618	20	68	1.0	733	0.062	68	111	3.0	25700	22500	15	16						
0.5	11356	2316	0.459	13360	2725	85.5	186	1.222	290	0.062	111	133	4.0	37000	35000	15	16						
0.333	142.0	2869	0.374	17767	3618	130.4	267	1.375	320	0.150	133	155	4.8	48500	45000	15	16						
0.25	16580	3383	0.329	21296	4326	165.6	330	1.495	384	0.196	155	177	5.4	58500	52500	15	16						
0.2	18175	3768	0.281	24310	4859	195.3	429	1.585	429	0.213	177	199	6.0	67000	60000	15	16						
0.167	20038	4087	0.252	27048	5317	230.5	470	1.681	470	0.240	199	221	6.4	75000	68000	15	16						
0.143	21422	4370	0.229	29518	5621	263.2	506.5	1.758	506.5	0.260	221	243	6.8	82000	74000	15	16						
0.125	22900	4660	0.210	31900	5890	282	539.6	1.828	539.6	0.274	243	265	7.2	89000	80000	15	16						
0.111	24400	4950	0.195	34200	6180	299	570.2	1.891	570.2	0.286	265	287	7.6	95000	85000	15	16						
0.100	25900	5240	0.180	36500	6470	316	599.0	1.950	599.0	0.298	287	309	8.0	100000	90000	15	16						

various methods of cooling. The air was compressed to 150 pounds gauge pressure, the work done in each case being represented by the area between the pressure curve and the rectangular lines.

The pressure curve is determined in each case by the formula—

$$\frac{P}{P_1} = \left(\frac{V_1}{V}\right)^N$$

In the case of isothermal compression (assuming no heat produced), the exponent $N=1$. In adiabatic compression (the full effect of the heat of compression being available), $N=1.408$. It is obvious that the value of the exponent N will vary between the two points 1, and 1.408. From a large number of indicator cards taken at the Stevens Institute the following values were shown:

Water jacket, - - - -	$N=1.35$
Water jet injection -	$N=1.33$
Water spray injection -	$N=1.25$

It has been demonstrated by experiments made in France that the power required to compress dry air has been prepared from the data of M. Mallard, and shows that for five atmospheres the work expended in compressing one pound of dry air is 58,500 foot pounds, while that for moist air is 52,500 foot pounds. In expansion also moisture in the air adds to the economy, but in both cases the saving of power is not great enough to compensate for the many disadvantages due to the presence of water. Mr. Norman Selfe, of the Engineering Association of N. S. W., has compiled a table which shows some important theoretical conditions involved in producing compressed air.

There are many serious objections, however, to the use of water within the air cylinder. These objections are so serious that it has been found to be the best practice to suffer the heat loss during compression, and thus simplify the apparatus. Some of the objections may be stated as follows:

1. The mechanical difficulties involved in introducing the water into the cylinder so intimately mixed with the air during compression as to reduce the temperature of compression immediately when produced.

2. Impurities in the water, which, through both mechanical and chemical action, destroy exposed metallic surfaces.

3. Wear of cylinder, piston and other parts, due directly to the fact that water is a bad lubricant; and as the density of water is greater than that of oil, the latter floats on the water and has no chance to lubricate the moving parts.

4. Wet air arising from insufficient quantity of water and from inefficient means of ejection.

5. Mechanical complications connected with the water pump, and the difficulties in the way of proportioning the volume of water and its temperature to the volume, temperature and pressure of the air.

6. Loss of power required to overcome the inertia of the water.

7. Limitations to the speed of the compressor, because of the liability to break the cylinder head joint by water confined in the clearance spaces.

8. Absorption of air by water.

Before the introduction of condensing air receivers, wet air resulting in freezing was considered the most serious obstacle to water injection; but this difficulty no longer exists, as experience has demonstrated that a large part of the moisture in compressed air may be abstracted in the air receiver. Even in the so-called dry compressors a great deal of moisture is carried over with the compressed air, because the atmosphere is never free from moisture. This subject will be referred to more fully when treating of the transmission of compressed air.

A serious obstacle to water injection, and that which condemns the wet compressor, is the influence of the injected

water upon the air cylinder and parts. Even when pure water is used, the cylinders wear to such an extent as to produce leakage and to require reborings. The limitation to the speed of a compressor is also an important objection. The claim made by some that the injected water does not fill the clearance spaces, but is aerated, does not hold good, except with an inefficient injection system.

Whether it be water or spray which occupies the clearance space, it is impossible for air and spray to occupy the same place at the same time.

The writer has increased the speed of an air compressor (cylinders 12 in. and 12 in. by 18 in., injection ten revolutions per minute by placing his fingers over the orifice of the suction pipe of the water pump. The boiler pressure remained the same, the cut-off was not changed and the air pressure was uniform, hence this increase of speed arose from the fact that the water was restricted and the clearance spaces were filled with compressed air, which served as a cushion or spring. While the volume of compressed air furnished by this compressor would be somewhat reduced by the restriction of the water, yet the increase in speed which was obtained without any increase of power, fully compensated for the clearance loss.

Unless the water of injection can be used efficiently as a cooling agent, its value for clearance does not compensate for the disadvantages attending its use. In some of the early types of air compressors water was introduced through the inlet valves during the suction stroke; but this is an objectionable plan, because it has little effect on the heat produced until the discharge of the air, and furthermore, there is the danger of introducing too much water, and thus reducing the volume of air and endangering the cylinder heads.

The presence of moisture in the air re-

duces the heat loss, hence, as shown by Table No. 4, less power is required to compress moist than dry air. It is not necessary to inject water during compression in order to gain this advantage, as the atmosphere is usually moist. The presence of moisture in the air has an important bearing upon the compression, transmission and use of air. Before compressed air became generally used, its value was thought to be prohibitive, mainly because it was said that the air would freeze. This freezing was, of course, nothing more than the formation of ice due to the presence of moisture in the air, this moisture having been first deposited in the shape of water by expansion and cooling, and afterwards, the temperature going down below the freezing point, it became ice. This has some time since ceased to be a serious matter, and on the whole the presence of the moisture has been found to be more beneficial than otherwise, because by increasing the specific heat of the body with which it is in contact, it reduces the temperature during compression and tends to increase it during expansion. In transmission it is simply necessary to keep the temperature from falling below the dew point, or to put in suitable receivers for draining the pipes. Where reheaters are used, the presence of moisture is decidedly advantageous.

The amount of moisture in the atmosphere varies with the climate. Air is never perfectly dry; never, except in rare instances, does it contain less than 25 per cent. of the moisture necessary to saturate it. It is not an uncommon thing to read in the meteorological reports in the newspapers during the summer that the moisture during an oppressively hot day reached 98 per cent., and even 99 per cent. In winter it is usually 80 or 85 per cent. At 65 per cent. we consider it moderately dry; 50 per cent. being commonly called dry air.

W. L. SAUNDERS.

COMPRESSED AIR AND ITS ECONOMIES IN THE FOUNDRY.

Perhaps in no other operation in the foundry is air used to such good advantage as in hoists and cranes. By using direct acting hoists suspended from trolley tracks and using detachable air hose couplings, a casting or other weight can be readily conveyed to any part of the foundry, or carried outside the foundry building to the machine or pattern shop, or in fact to any point around the establishment that may be desired, thus covering a field vastly wider than is possible with a traveller alone.

The great economy of an air hoist is well illustrated in the following record of actual work performed in the foundry of Messrs. Russell & Co., of Massillon, Ohio.

In making wheels for their traction engines, a molder and helper formerly made one mold per day of a wheel 16 inches face by 66 inches diameter. During the entire operation of molding and pouring, 104 hoists and lowers were necessary. With the old crane it took these two men from five to six minutes to turn a flask when assisted by a laborer on the windlass. Now, with the air hoist, the laborer is done away with, and they turn a flask in two minutes. This saves in time alone 52 times $3\frac{1}{2}$ minutes, or *three hours per day*, and the molder and helper make two 58-inch by 12-inch wheels in addition to the large wheel, which formerly constituted a day's work, in the time saved in moving by the air hoist.

In this same foundry a test of one of their jib cranes gave the following:

Area of piston, 452.39 square inches (24 inches diameter).

Height of lift, 6 feet.

Hoist, 2 feet to 1 foot of piston travel.

Weights lifted, 2,000, 4,000, and 5,000 pounds.

Main air receiver gauge, 100 feet from crane, registered 63 pounds pressure.

Gauge on hoisting cylinder, 30, 40 and 45 pounds for the respective hoists.

It was found that it took ten pounds pressure on hoisting cylinder gauge to overcome all the friction of the chains wrapping around the sheaves, as well as the packing in the stuffing box of piston rod and the frictional resistance of the piston against the cylinder walls.

Weight lifted 6 feet.	Pressure on Piston.	Deducting 4523.9 lbs. as being amt required to over- come all resistance except load, we get
2,000 lbs.	6785.85 lbs.	2261.55 lbs.
4,000 "	9047.80 "	4523.9 "
5,000 "	10178.77 "	5654.87 "

The excess of 261.55, 523.9, and 654.87 lbs. in the respective cases, is, no doubt, due to the fact that the chains are hugging the sheaves tighter under the loads than when empty; and this increased friction must be overcome at the expense of pressure. The ten pounds required to overcome the load and frictional resistance of the chain, chain block, etc., in the crane itself, is not altogether wasted, for the space in the cylinder between the piston and the head on the lifting side being once supplied with this amount, is then ready to do useful work. A 24-inch cylinder with piston moved 3 feet, would contain 28,275 cubic feet of free air if the gauge on the cylinder showed 30 pounds, or two atmospheres pressure, and ten such hoists would use $282\frac{3}{4}$ cubic feet of free air. This amount of air would not cost over one and one-half cents. With compressed air at five cents or less per 1,000 cubic feet of free air delivered at 100 pounds pressure, this is vastly cheaper than a gang of men, on a windlass, with the molders standing idle an indefinite time. The frictional loss in direct air hoists has been shown by tests made by the Whiting Foundry Equipment Co. not to exceed 15 per cent. A lot of 12 hoists taken at random showed a varying loss of from 9.2 to 23 per cent., average 12.9 per cent. loss.

Another lot of ten averaged 14.65 per cent. loss.

Mr. Chas. O. Heggem, the well-known compressed air expert, uses compressed air for breaking test bars, and at the same time automatically recording the shrinkage and deflection. The pattern for the test bars is $2\frac{1}{4}$ inches long, and in the case of a bar tested, the register showed a shrinkage of 9-64 in. to the foot; deflection, $\frac{1}{2}$ in. in 24 inches; and the bar, which was 1 in. square, broke under a pressure of 1,375 pounds.

In view of the great variety of ways (more or less unsatisfactory) of testing the qualities of iron as expressed last May at the meeting of the foundrymen in Philadelphia, Pa., it would appear that the majority of foundries using air could adopt Mr. Heggem's idea with advantage.

Compressed air cranes have many advantages over those electrically driven for foundry work, as the dust and heat which materially affect the efficiency of electric motors have no appreciable effect on the air motors.

Few if any of the compressed air driven machines that have been introduced for foundry work serves a better end than the sand blast. By its aid, castings that were hitherto cleaned with the greatest difficulty can now be cleaned in a remarkably short time, and with a tithe of the exertion formerly necessary. For instance, a casting which was made with a core that was almost impossible to get out satisfactorily, and which took 45 minutes to clean by hand, was cleaned by the sand blast in 16 minutes. Six and one-half minutes of this time was occupied by chipping out a fin to allow the blast to reach the core.

The waste sand from a sand blast can be used to advantage in making cores when mixed with the core sand in proportion of about 1 to 4.

Another important use of compressed air is in connection with the molding machine.

By its use the expense of stripping plates is entirely done away with, and by using an air jet to blow sand from the pattern instead of using a bellows and brush, much time is saved. The use of air permits the molding machine to be moved to any part of the foundry, and it is decidedly cheaper to bring the molding machine to the sand pile rather than wheel the tons of sand to the machine.

A deeper draft is possible using air than can be obtained with a steam-actuated machine. In general, a molding machine operated by compressed air is portable, independent of any foundation, and can be connected to the air main by a hose and used in any part of the foundry, which is not possible when using steam. It makes molds without the use of stripping plates, in fact uses ordinary split-wood or metal patterns fastened by wood screws to the pattern plate. This is accomplished by the use of an automatic rapping attachment which frees the pattern from the sand, without any amplitude of motion in the pattern, while it is being drawn. This compressed air molding machine weighs and costs but little more than a hand machine, and has all the advantages in point of output and size of flasks of power machines. Observation of an air-actuated molding machine operated by two helpers at \$1.50 per day each, showed that on certain work containing 12 small cores per mold, they put up 50 molds per day. Formerly it took four helpers, at the same wages, to make 50 molds by hand per day, thus gaining a saving in wages of 50 per cent.

In another case, on new work, the first day two helpers at \$1.50 each per day, turned out 35 molds. The best record on this work for a molder working by the piece was 7 molds per day.

The product of a molding machine can be greatly increased if the handling of the sand in shovels is done away with. This is accomplished by an air jet which at 60

lbs. pressure will lift 100 lbs. of sand per minute 20 feet high. A quarter-inch nozzle will use 90 cubic feet of free air per minute doing this duty. By elevating the sand to a bin overhead and then conveying it in a chute or pipe directly over the molding machine, much time and labor can be saved.

A simple slide in the pipe forms a ready means of regulating the amount of sand served to the machine for each mold.

After deciding to adopt compressed air as a labor-saving aid in the foundry, the most important points for consideration are the type or style of compressor to install, and its size or capacity. Only too frequently, confined space, together with a disinclination to expend more than will barely suffice for present needs, act as a handicap and incline the founder to decide upon a plant that "will do somehow," rather than one that his cold, unbiassed judgment would dictate as being best suited to his needs. It is the exception to find a plant too large even for present needs, for while starting out with the best intentions to allow for a reserve, the ingenious foundrymen originate so many little labor-saving shop kinks that before long there is a demand for more air, and the engineer is told to "speed her up a few turns."

When it is decided to use air hoists, cranes, molding machines and other air-actuated machinery, it is imperative to bear in mind that if the air supply stops through breakdown or insufficient capacity, the whole foundry is practically at a standstill. If there is no air to operate the hoists, the men cannot handle their work, and great loss ensues.

It is clearly of the utmost importance that the source of air supply must be adequate to all reasonable demands and must be of such staunch and durable design and construction as will insure its ability to easily meet the increased duty when called upon to "speed up a few turns." These

"few turns" usually mean about 20 per cent. increase, and it is only the very best high duty compressors that will survive such a test.

It is an open question, which must be largely decided by the individual conditions in each foundry, whether a steam driven or belt compressor is most desirable. When there is shafting already in the foundry and a good dust-tight room can be provided, it is perhaps cheaper to put in the belt driven type. The steam compressor has its advantages, however, as it can be located in the engine room under the supervision of the engineer, and the necessity for shafting and belting obviated. As the best steam-actuated compressors now use steam very nearly if not quite as economically as the majority of shop engines, low efficiency cannot be urged against their use with the same force as formerly.

The steam machine can be run at a speed to suit the requirements of the foundry by regulating the throttle.

CURTIS W. SHIELDS.

A New Bolt Thread Cutter.

An appliance for cutting bolts and threads has been invented by Mr. J. H. Ferguson, Asst. M. M. of the Meadow Shops, P. R.R., Jersey City, N. J.

The inventor claims that his device is to provide an automatic attachment for the feed portion of a bolt machine, by which the bolts to be threaded are delivered, and when the threads are cut, removed from the "die holder" of the ordinary type of bolt threading machine, automatically, and much more rapidly than the usual method. The attachment also automatically opens and closes the dies, it being only required of the operator to lift the bolt out when it is cut, and replace it with one to be cut, thereby greatly simplifying his labor, and necessary skill.

The means for accomplishing this result are, first, compressed air acting in a cylin-

der fitted with a piston and piston rod; second, a valve and connection for automatically controlling the admission of air to either end of the cylinder; third, a rigid bed, secured to the original bed of the machine, and to which the cylinder is fastened; fourth, a sliding plate, having a longitudinal motion, on the bed parallel to the axis of the die shaft, and being rigidly connected to the piston rod; fifth, a round turret or monitor, revolving on the slide plate, being so revolved (when the slide plate is moved by the action of the compressed air in the cylinder) by means of a latch, engaging in pins which are set in a disc on the under side of the slide plate, the disc, through the medium of a square bolt, revolving the turret; sixth, a locking device for securing the turret in a certain position during the cutting of the bolt, yet permitting it to turn when the latch engages the pins; seventh, the bolt holders in the turret, for securely holding the bolts in a proper position for cutting the threads, and allowing them to be easily removed and replaced; eighth, the substitution of a vise for holding work too long for the turret, the turret being removed.

When the compressed air is turned on, it starts the machine, the die holders revolving as usual; the air entering the back of the cylinder, acting against the piston, forces the slide forward, and presses the bolt (held in the turret) against the dies which begin to cut the thread. As the thread is being cut, the valve plug is gradually turned until air is admitted to the opposite end of the cylinder, and tends to pull back on the slide; therefore, when the die holder opens, the slide moves back, the lock pin is withdrawn, the turret turned, until a new bolt is brought into line, the die is closed, and the valve plug again admitting air to the back of the cylinder, a fresh bolt is forced to the die, the bolt just cut is then lifted out and another substituted, and there are always five uncut bolts in the turret.

COMMUNICATIONS.

IRON MOUNTAIN, MICH., Sept. 4, '96.

W. L. SAUNDERS,

Editor of COMPRESSED AIR:

In an article by you in "COMPRESSED AIR" for March, I notice you mention the compressor plant at Quinnesec Falls as not being an economical plant. In this connection permit me to say that the plant in question, which furnishes all the power necessary to do the hoisting, tramming, drilling with nearly 100 rock drills, operating shops and electric light plant and about half of the pumping for a mine that produces annually over 600,000 tons of ore and two and three-quarter million tons of water from a depth of 500 feet at a cost for operating, including taxes, insurance and repairs, of 2.1 cents per ton of ore produced, must of necessity be economical.

The impression that this plant is not economical was gained from a test made in 1888, which showed that of the horse power developed at the compressor plant, only 27.3 per cent. was realized at the mine. This test was very misleading because of the fact that the air was used at the mine in the crudest of machinery, such as direct acting steam pumps, Rochester hoists, rock drills, etc. When we stop to consider that according to the test the steam pumps only developed from 6 to 14 per cent., the Rochester hoists about 15 per cent., and the rock drills about 22 per cent. of the horse power necessary to produce the air to operate them, it is no wonder that the general result was so low. In the same test it was shown that, not considering any loss due to friction or leakage through the three miles of main pipe and probably one thousand or fifteen hundred feet of smaller pipes with innumerable bends, almost 80 per cent. of the air produced at the falls was accounted for at the mine, when figured at the same temperature and pressure as that of the air produced.

From a commercial point of view the plant is a success, as will be seen by a comparison between the cost for fuel and compressed air at the present time, as against the cost for fuel the year before the compressed air plant was installed. This comparison shows for twelve years a net annual saving of a little over \$50,000. An investment of \$400,000, making a net annual return of $12\frac{1}{2}$ per cent., is certainly a good one.

Yours truly,

JAS. MACNAUGHTON,

General Manager.

Pneumatic Horse-Collars.

The bicycle craze and the numerous fads of the day have not entirely done away with the love for that noblest of animals the horse, and while its devotees are considerably fewer than a few years ago, there are still many who cling to the thoroughbred and are constant in their search for inventions which may be of use to a horse or conducive toward the lightening of its work.

An Albany, N. Y., gentleman, touring in Europe not long ago, came across a new invention in the shape of a pneumatic horse-collar. It was in Milan, Italy, that the Albanian saw the new kind of collar, and, charmed with its qualities, he ordered two of them made and sent to his home.

These collars arrived in Albany a few weeks ago, and were placed on exhibition at George L. Russell's stable, No. 362 State street, where they were examined by a number of well-known lovers of horseflesh and heartily approved. Both collars are pneumatic, and one is finished in black, while the other is in russet. They are the only collars of the kind in the country. The collars, in appearance, are similar to the ordinary horse-collar of superior workmanship, but instead of the usual packing of horsehair and straw, there are pneumatic tubes which are blown up and made to fit

the horse's neck, much the same as the tire on a bicycle. The collars are of the finest workmanship, and took the first prize offered by the Society for the Prevention of Cruelty to Animals at the exhibition held in Milan during 1895.

The principal features of the collar are its velvet-like surface and extreme lightness. No horse wearing this collar will be troubled with galling or chafing, for the make-up of the collar prevents both.—*Blacksmith and Wheelwright.*

An Air Compressor of Exceedingly Novel Design.

An air compressor of exceedingly novel and original design has been practically finished by the Chaquette Power Company of Bridgeport, Conn., in accordance with the plans of E. Chaquette, the inventor of the machine.

The machine is calculated to develop 2,500 horse power in the shape of air under a pressure of 100 pounds to the square inch, which it is the intention of the company to distribute through mains for power purposes. The compressor is, essentially, an immense horizontal wheel composed of ten spokes or arms, each formed of two latticed girders connected by suitable bracing. The girders forming each spoke diverge from the centre or hub toward the periphery, and they are united at their outer ends by an encircling system of latticed girders. The general arrangement of the wheel thus formed will be understood from the approximately correct plan view, Fig. 2.

Journalled in the outer end of each spoke is a set of three solid wheels which are 9 feet in diameter and each of which weighs about $4\frac{1}{2}$ tons. The centre wheel of each set of three travels upon a circular track, as indicated in Figs. 1 and 2. The track is beveled after the manner of the ordinary bridge turn table track. The other two wheels, the inner and outer, of each set are the actual working wheels of the system,

as they operate the air compressors placed around the circular track, which is 82 feet in diameter.

The centre of the wheel is supported upon a rivet provided with a ball bearing placed on a masonry foundation. The hub A, Fig. 2, is formed with a platform in which are placed two compound steam engines, each of 70 horse power. Each engine shaft carries a pinion which engages with an internal gear on the shaft B, Fig. 2. These two shafts, B B, are diametrically

Fig. 4. Each of the 100 compressors has cylinders 12 and 16 inches in diameter and a common stroke of 12 inches. Pivoted centrally above each pair of compressors, in a bracket secured to the wall of the track, is a rocker, lever shaped, as shown in Fig. 1. Each end of each lever is connected by a link with the piston rod of a compressor. Each lever upon the outside of the track is so located as to be in the line of travel of all the outside wheels of all the sets of three. Each lever upon the

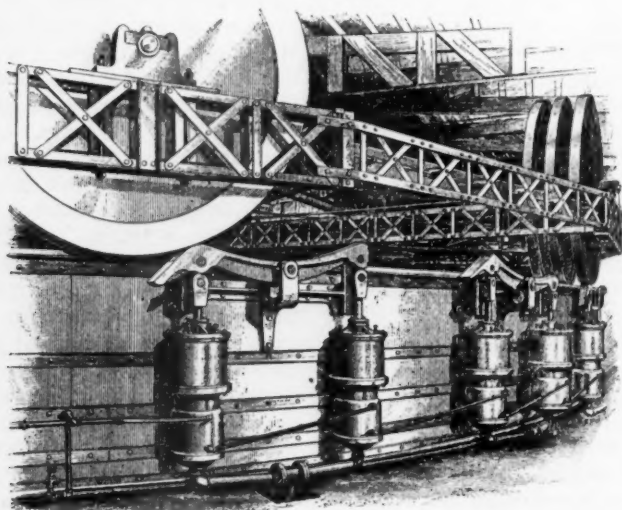


FIG. 1.

opposite each other, and on the outer end of each is rigidly mounted the centre wheel of the sets D D. The great wheel is therefore driven by the engines, which are independent of each other, through the shafts B B and centre wheels of the sets D D.

Placed vertically in pairs around the outside of the track are 50 compound air compressors, as shown in Fig. 1. Arranged in the same way around the inside of the track are 50 similar air compressors, as shown in

inside of the track is placed in the path of the inside wheels. The rocker levers are so formed and arranged as to be struck by the wheels in their passage, and through the connecting links to operate the pistons of the air compressors.

The air tank is in the centre. There is also a 20-inch collecting main, which extends around the inside of the track, and with which suitable pipe connections are made with each compressor. This main

conveys the air to the tank, which is expected to carry a working pressure of 100 pounds to the square inch, this pressure having been decided upon as it is the most available one for power distribution.

The operation of the machine will be readily understood. If the wheel should make ten revolutions per minute, there will be 100 impulses or strokes of the air compressors at each revolution, and 10,000

the multiplication expected is something tremendous. As stated by Mr. Chaquette to our representative, it is calculated that of the total power developed, only about $4\frac{1}{2}$ per cent. will be required for the actual turning or operation of the wheel, and that the remaining amount, or about $95\frac{1}{2}$ per cent., will be available for commercial purposes. The momentum of the wheels carried at the ends of the arms or spokes,

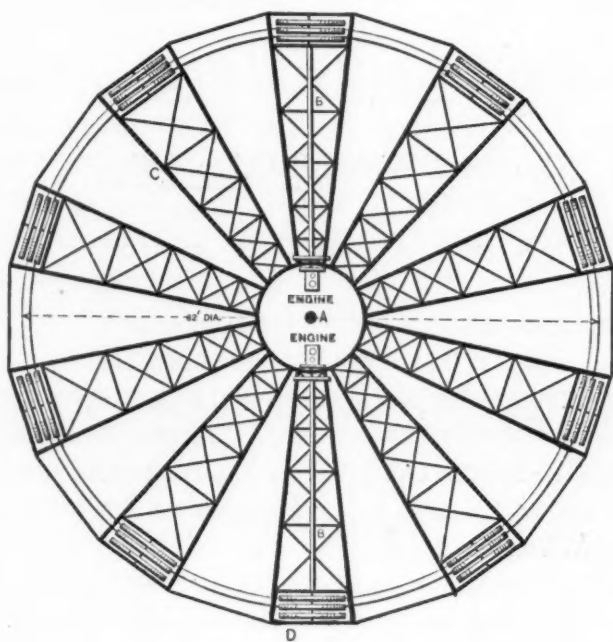


FIG. 2.

for the ten revolutions it is expected to make in each minute. Knowing the capacity of each compressor, it therefore becomes a mere matter of calculation to ascertain the power developed and made available, as air under pressure, if the wheel could be run at ten turns per minute. Taking into consideration the actual power applied at the centre to turning the wheel,

their great weight compared with the work they are expected to perform, and the constantly increasing leverage of their action upon the several rocker levers, are depended upon for the successful operation of the machine. It may be added in conclusion, that the machine has been protected very completely by letters patent issued to Mr. Chaquette.—*The Iron Age*.

COMPRESSED AIR.

A Few Features in the

HOGAN WATER TUBE BOILERS

Which Make Evident Their Superiority When
Compared With All Other Boilers.



NO SCALE accumulates on the HEATING SURFACES.

DRUMS not exposed to the heat COLLECT all SEDIMENT.

Each STEAMING TUBE discharges directly INTO the STEAM SPACE.

Each water CIRCULATING TUBE discharges DOWNWARD into the DISTRIBUTING DRUMS, where PRECIPITATION of the impurities TAKES PLACE.

WATER FLOWS into the heating tubes as rapidly AS STEAM is produced in them and ESCAPES from them.

Tubes CANNOT BURN because the WATER CANNOT be forced out of them BY the production of STEAM and NO HARD SCALE deposits IN THESE TUBES.

Steaming TUBES are OVER the FIRE and are exposed to the DIRECT ACTION of the heat of the FIRE and the GASES.

The water CIRCULATING TUBES are not exposed to the heat so as to secure DOWNWARD CURRENTS.

STEAM can be raised IN TWENTY MINUTES without injury to any part.

Send for Boiler Review, No. 4, and Truths and Proofs.

HOGAN BOILER COMPANY,

MIDDLETOWN, N. Y., U. S. A.



VALVE LEATHER,
HYDRAULIC LEATHER,
PUMP LEATHER,

OF ALL KINDS AND DESCRIPTIONS
MANUFACTURED BY



CHAS. A. SCHIEREN & CO.,
Tanners and Manufacturers,

NEW YORK: 45-51 FERRY STREET.

BOSTON: 119 HIGH STREET.

CHICAGO: 46 SOUTH CANAL STREET.

PHILADELPHIA: 226 NORTH THIRD STREET.

TANNERY AT BRISTOL, TENN.

THE BENJAMIN ATHA & ILLINGWORTH CO.,

Manufacturers of all grades of

BAR = STEEL,

— ALSO —

Steel Forgings and Steel Castings.

General Office and Works: Harrison, N. J.

New York: 93 John Street.

The Wolstencroft Pneumatic

Tool Co.,

(Frankford)

Philadelphia,

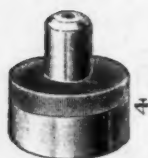
Pa.



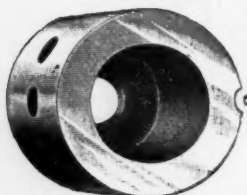
The Simplest and Most Efficient Pneumatic Tool in the Market. Designed for caulking boilers, beading boiler flues and chipping metals of all kinds.

We are equipped to furnish an estimate on complete air plant as well as all sizes and kinds of pneumatic tools. Hammers from $\frac{1}{4}$ inch diameter, weight 93 grains, to 2 inch diameter, weighing $2\frac{1}{2}$ lbs.

Efficiency Guaranteed for Five Years.



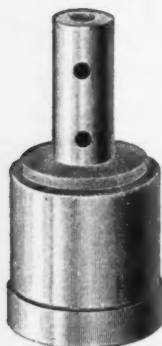
4-ANVIL



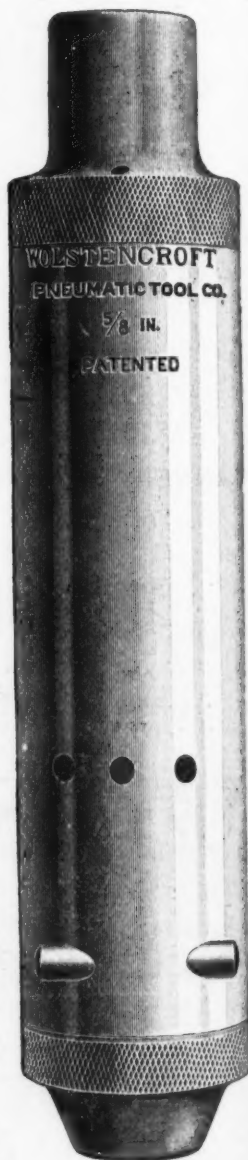
3-BUSHING



2-HAMMER



1-VALVE



COMPRESSED AIR.

5

McNAB & HARLIN M'F'G CO.,

MANUFACTURERS OF

BRASS COCKS,

PLUMBERS' BRASS WORK,

Globe Valves, Gauge Cocks, Steam Whistles and Water Gauges,

WROUGHT IRON PIPE AND FITTINGS,

Plumbers' and Gas Fitters' Tools,

No. 56 JOHN STREET,

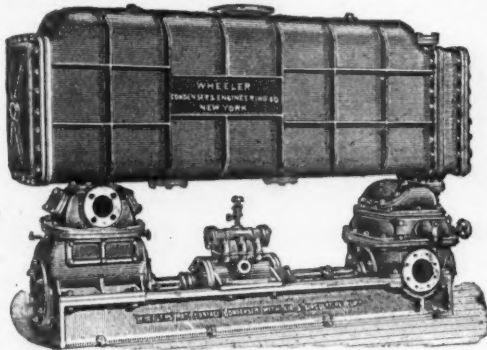
NEW YORK.

Factory, Paterson, N. J.

Wheeler Condenser & Engineering Co.

39-41 CORTLANDT STREET, NEW YORK.

For
MARINE
and
STATIONARY
SERVICE.

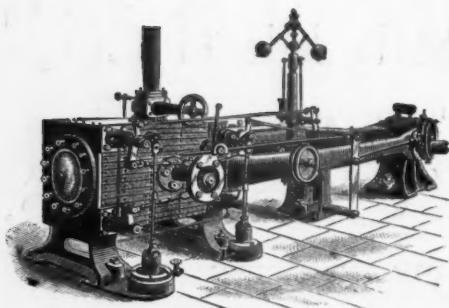


SURFACE
CONDENSERS
Mounted on
Combined Air
and
Circulating
Pumps.

PROPRIETORS AND MANUFACTURERS OF

WHEELER STANDARD SURFACE CONDENSER; WHEELER ADMIRALTY
SURFACE CONDENSER; WHEELER LIGHTHALL SURFACE CONDENSER;
VOLZ PATENT SURFACE CONDENSER AND FEED WATER HEATER;
EDMISTON PATENT FEED WATER FILTER.

WHEELER'S PATENT FEED WATER HEATER.



Established
1833.



The
C. & G. COOPER CO.

MT. VERNON, OHIO.

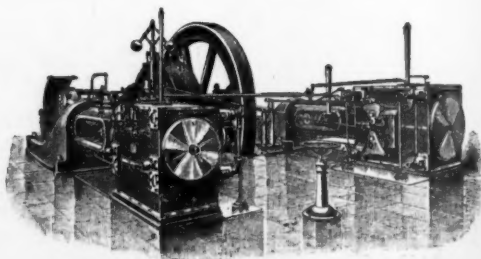
CORLISS ENGINES.

COMPOUND.

TRIPLE EXPANSION.

SINGLE CYLINDER.

Of all sizes up to 3,000
Horse-power.



— FOR —

FACTORIES, RAILWAYS, ELECTRIC LIGHTING,
ROLLING MILLS, AND ALL KINDS
OF MANUFACTURING.

CORRESPONDENCE SOLICITED.

HOME OFFICE: MT. VERNON, OHIO.

NEW YORK: Room 1022 Havemeyer Building, F. W. IREDELL, Mgr.

THE PULSOMETER STEAM PUMP

"The Contractor's Friend."

***OFTEN IMITATED—NEVER EQUALED.
OVER 20,000 IN USE.***

Recent Important Improvements.

The Handiest, Simplest and Most Efficient Steam Pump for General Low Service Mining, Quarrying, Railroad, Irrigating, Drainage, Coal-washing, Tank-filling, Paper Mill, Sewer and Bridge Contractors' Purposes, etc., etc.

Muddy or gritty liquids handled without injury to the Pump.



PULSOMETER STEAM PUMP CO.

Catalogue on Application.

Correspondence Solicited.

135 GREENWICH STREET, NEW YORK.

C. H. TUCKER, JR.

Contractor's and Machinist's

SUPPLIES,

SOLE AGENT FOR

Lightning and Green River Taps and Dies,

Bolt Cutting Machinery,

Eagle Sight Feed Lubricators,

Crane's Portable Drills.



135 GREENWICH STREET,

NEW YORK.

Do You Roast Your Ores?

. . . . YOU CAN SAVE

FUEL, COST OF REPAIRS AND LABOR,
BY USING

The Ropp Straight Line Furnace,

FOR SALE BY

PARKE & LACY CO.,

21 & 23 Fremont Street,

San Francisco, Cal.

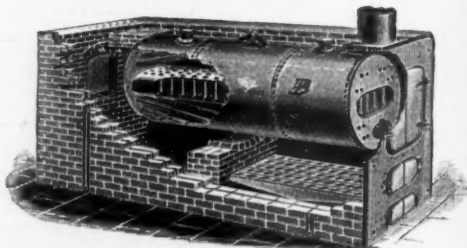
SOLE LICENSEES.

CATALOGUE UPON APPLICATION.

BOILERS AND ENGINES.

BOILERS—STATIONARY RETURN
TUBULAR; WATER TUBE, LO-
COMOTIVE, VERTICAL. SCOTCH
MARINE. BOILERS ON WHEELS
OR SKIDS.

ENGINES—HIGH—MODERATE—
SLOW SPEEDS—HORIZONTAL—
VERTICAL—SINGLE AND DOUBLE
COMPOUND AND TRIPLE EX-
PANSION.

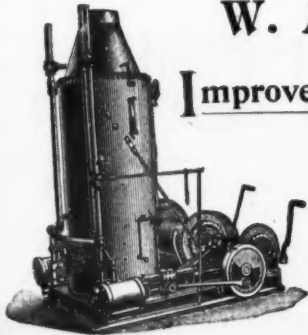


STEAM PLANTS SPECIALLY ADAPTED FOR DRILLING AND
MINING MACHINERY.

PIERCE & MILLER ENGINEERING CO.,

26 CORTLANDT STREET,

NEW YORK CITY, N. Y.



W. A. CROOK & BRO.'S CO.,
Manufacturers of
Improved Hoisting Engines,

FOR PILE DRIVING, RAILROADS, BRIDGE
BUILDING, MINES, QUARRIES, COAL
HOISTING AND BUILDING PURPOSES.

BUILT ON THE DUPLICATE PART SYSTEM.

OVER 350 SIZES AND STYLES.

Log Hauling by Steam and Suspension
Cableways.

BOSTON OFFICE:

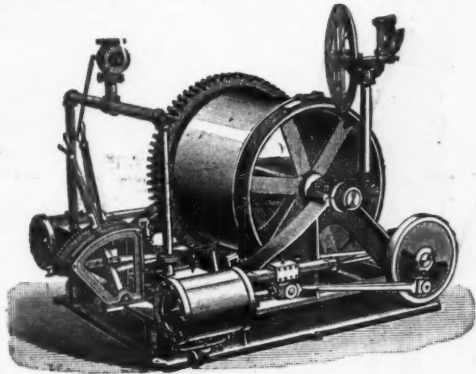
47 Pearl Street, cor. Franklin.

MAIN OFFICE AND FACTORY:

117-123 Poinier Street, Newark, N. J.

SALESROOM:

143 Liberty Street, - New York.



THE

Ohmer Dust-Proof Cabinets

Will give the best satisfaction for any and all purposes of filing. They occupy but little floor space, are of large capacity, and easily operated.

The best is always cheapest.

Write for particulars.

The M. OHMER'S SONS CO.

73 Nassau St., New York.

Home Office & Factory: Dayton, O.

Compressed Air.

Practical information upon Air-Compression
and the Transmission and Application
of Compressed Air.

By FRANK RICHARDS.

12mo, cloth, \$1.50

John Wiley & Sons, New York.

JAMES McCARTNEY,
Contractor and Builder,

1199 FULTON AVENUE,

NEW YORK.

Patents, Trade Marks, Designs.

Searches as to Novelty; Reports on Infringements;
Patent Matters Exclusively; 15 Years Experience.
Refers to Publishers this Magazine.

FRANKLAND JANNUS,

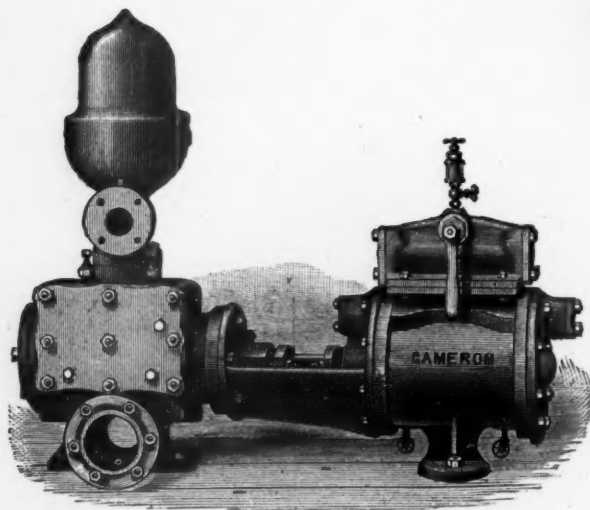
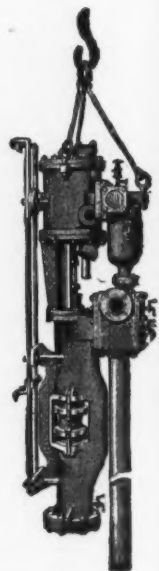
Attorney-at-Law, Atlantic Bld., Washington, D. C.

Always have Title Examined before Investing in
Patent Property.

CAMERON STEAM PUMPS.

Simple,
Compact,
Durable,
Efficient.

NO OUTSIDE VALVE GEAR.



ADAPTED TO EVERY POSSIBLE DUTY.

MANUFACTURED BY

THE A. S. CAMERON STEAM PUMP WORKS,

Foot East 23d Street, New York.

 STEAM AND AIR DRILL HOSE A SPECIALTY.

THE MANHATTAN RUBBER MF'G CO.

CABLE ADDRESS "MIALOGIA"
TELEPHONE, 2965 CORTLANDT

Steam Packing,
Pump Valves,
Air Compressor Valves,

Rubber
Belts,

Car
Springs,

Gaskets,

Suction
Hose,

Emery Wheels,



FRANK CAZENOVE JONES,
PRES'T AND GEN'L M'GR.

ALL KINDS OF MECHANICAL RUBBER GOODS.

Factories:

General Office and Salesroom:

Passaic, N. J. (on D. L. & W. R. R.) 64 CORTLANDT ST., NEW YORK.

SEND FOR ILLUSTRATED CATALOGUE.

Electric Blasting.



Victor Electric Platinum Fuses.

Superior to all others for exploding any make of dynamite or blasting powder. Each fuse folded separately and packed in neat paper boxes of 50 each. All tested and warranted. Single and double strength, with any length of wires.

"Pull Up" Blasting Machine.

The strongest and most powerful machine ever made for electric blasting. No. 3 fires 30 holes. No. 4 fires 50 holes. No. 5 fires 100 holes. They are especially adapted for submarine blasting, large railroad quarrying and mining works.

Victor Blasting Machine.

No. 1 fires 5 to 8 holes; weighs only 15 lbs., adapted for prospecting, stump blasting, well sinking, etc.

STANDARD ELECTRIC FUSE AND BLAST TESTER, WIRE REELS (New Design), LEADING AND CONNECTING WIRE.

MANUFACTURED ONLY BY

JAMES MACBETH & CO., 128 Maiden Lane, New York City

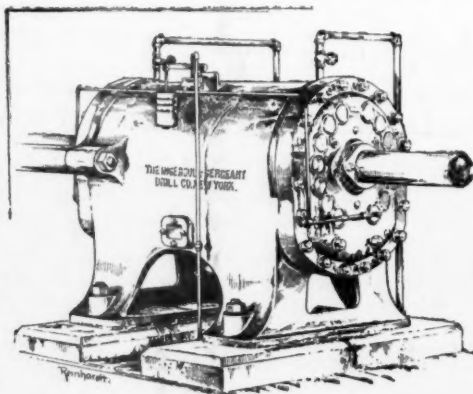
The Piston Inlet

Air Compressors.



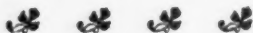
Valves after five years of hard use.

Used by
Anaconda Mining
Co.
Erie R. R. Co.
Cambria Iron Co.
Nottingham
Colliery.
Jerome Park
Reservoir.
And shops
of every
description.

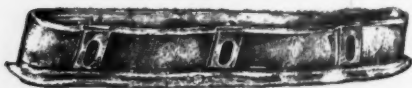


Features :
Piston Inlet
Valves.
Automatic
Unloading
Device.
Water Jacketed.
Efficient Cooling.
Minimum
Clearance.
Simplicity.

High Duty Compressors, Straight Line, Half Duplex and Duplex.



Effect of Steam Hammer on a
Piston Inlet Valve.



Bent but not broken.



THE
**Ingersoll-
Sergeant
Drill Co. . .**
Havemeyer Building,
New York.

Send for Catalogue.